International Journal of Electronics,
Communication & Instrumentation Engineering
Research and Development (IJECIERD)
ISSN(P): 2249-684X; ISSN(E): 2249-7951
Vol. 4, Issue 3, Jun 2014, 41-46
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TRANS STELLAR
• Journal Publications • Research Consultancy

MONITORING OF ANALGESIC COMPONENT DURING ANAESTHESIA

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ABSTRACT

The Monitoring of Analgesic Component during Anaesthesia is indirect and, in essence, of the moment. Under general anaesthesia, analgesia is continually influenced by external stimuli and the administration of analgesic drugs cannot be really separated from anaesthesia: the interaction between analgesia and anaesthesia is inescapable. Physiological methods of monitoring must be used to assess anaesthetic depth as normal reflex methods will not be reliable. Nerve stimulators could be used to assess neuromuscular function objectively during anesthesia. Muscle Relaxants are employed in anaesthesia for muscular relaxation and/or abolition of patient movement. Monitoring of the degree of neuromuscular block is accompanied by delivering an electrical stimulus near a peripheral motor nerve and evaluating the evoked response of the muscle innervated by that nerve. In order to cure pain, a physician must know the quantity of sufferer's pain exactly. Otherwise, the physician may prescribe a wrong dosage of pain killers; it may lead to side effects. Therefore, it is essential to measure the pain objectively and we need some quantitative indicator of pain. This work aims to verify whether Galvanic Skin Response (GSR) can be used as a valid pain indicator and to analyze the changes in GSR during analgesic condition. The experiments will be done under pain and no-pain conditions on subjects of both the gender in the different age group. The results will show a relation between Pain and GSR and there is a scope for measuring pain objectively using GSR. The subjects do not feel pain during analgesia and GSR is a true indicator of pain.

KEYWORDS: Pain, Analgesia, Nerve Stimulation, Galvanic Skin Response

INTRODUCTION

Anaesthesia is a state of unconsciousness induced by a drug. The three components of anaesthesia are analgesia (pain relief), amnesia (loss of memory) and immobilization. Anaesthesia is an anaesthetic technique that reversibly inhibits the propagation of signals along nerves. When it is used on specific nerve pathways, effects such as analgesia (loss of pain sensation) and paralysis (loss of muscle power) can be achieved. Depending on their structure, the different nerves show varying susceptibility to the effects of anaesthesia.

Anaesthetic drugs act mainly by inhibiting sodium influx through sodium-specific ion channels in the neuronal cell membrane, in particular the so-called voltage-gated sodium channels. When the influx of sodium is interrupted, an action potential cannot arise and signal conduction is inhibited. There are various drugs available that could be used as anaesthetic agents. At present some of the most commonly used anaesthetic agents in clinical practice include Propofol, Desflurane, Isoflurane, Sevoflurane and Ketamine.

Analgesia is defined by the relief of pain, in other words by absence of pain in response to stimulation that would normally be painful. The monitoring of analgesia is indirect and, in essence, of the moment. Under general anaesthesia, analgesia is continually influenced by external stimuli and the administration of analgesic drugs, and cannot be really separated from anaesthesia: the interaction between analgesia and anaesthesia is inescapable. Autonomic reactions, such as

tachycardia, hypertension, sweating and lacrimation, although non-specific, are always regarded as signs of nociception or inadequate analgesia.

Physiological methods of monitoring must be used to assess anaesthetic depth as normal reflex methods will not be reliable. Nerve stimulators could be used to assess neuromuscular function objectively during anesthesia. Muscle Relaxants are employed in anaesthesia for muscular relaxation. Monitoring of the degree of neuromuscular block is accompanied by delivering an electrical stimulus near a peripheral motor nerve and evaluating the evoked response of the muscle innervated by that nerve. In order to cure pain, a physician must know the quantity of sufferer's pain exactly. Otherwise, the physician may prescribe a wrong dosage of pain killers; it may lead to side effects [1, 2]. Therefore, it is essential to measure the pain objectively and we need some quantitative indicator of pain. Use of neuromuscular (nerve) stimulators allows determination of the state of relaxation on a minute-to-minute basis.Stimulator can be used to diagnose unusual sensitivity to relaxants.

Traditionally, evaluation of neuromuscular function has used three patterns of electrical stimulation: single-twitch, train-of-four (TOF), and tetanic nerve stimulation. Two newer modes are also available: post-tetanic count (PTC) stimulation and double-burst stimulation (DBS) [6]. The apparatus should be capable of delivering the following modes of stimulation: TOF (as both a single train and in a repetitive mode, with TOF stimulation being given every 10–20 sec); single-twitch stimulations at 0.1 and 1.0 Hz; and tetanic stimulation at 50 Hz. In addition, the stimulator should have a built-in time constant system to facilitate post-tetanic count. Tetanic stimulus should last 5 seconds and be followed 3 seconds later by the first post-tetanic stimulus. At least one DBS mode should be available, preferably DBS. Electrical impulses are transmitted from stimulator to nerve by means of surface electrodes.

Neuromuscular function is monitored by evaluating the muscular response of muscle to supramaximal electrical stimulation of a peripheral motor nerve. The reaction of a single muscle fiber to a stimulus follows an all-or-none pattern. By contrast, the response of the whole muscle depends on the number of muscle fibers activated. If a nerve is stimulated with sufficient intensity, all muscle fibers supplied by the nerve will react, and the maximum response will be triggered. After administration of a neuromuscular blocking drug, the response of the muscle decreases in parallel with the number of fibers blocked. The reduction, in response during constant stimulation, reflects the degree of neuromuscular blockade.

THE NERVE STIMULATOR

An electrical muscle stimulation device is usually made up of two components: the stimulator that provides the current and a timer that regulates the length of the stimulation.

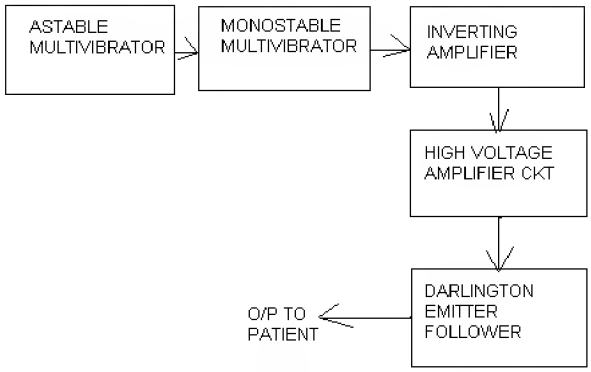

Figure 1: Block Diagram of Nerve Stimulator

In the muscle stimulator circuit (Figure 1) an a stable multivibrator, generates pulses at around 1 to 10 Hz. Astable multivibrators are unstable, in other words, they never stay in one state. They are used in stimulators because they are oscillators that can create pulses trains at a desired rate. The timer uses a monostable multivibrator. Monostable multivibrators have a single stable state and an unstable state. The unstable state can be triggered and the multivibrator will return to its stable (off) state after a certain amount of time. This characteristic makes it an ideal component for a timing device. The two parts of the device do not work synchronously. The timer and stimulator circuits usually have separate switches and voltage sources. The user is usually allowed to pick how long they would like to the stimulation to last. Thus, it is best to design a system where one switch triggers the stimulator and another triggers the timer. That way, the user can activate the timer switch, select the time of stimulation, and then activate the stimulator to begin treatment. Pulse width of monostable multivibrator can be 100, 200 or 500 microsec. The amplitude can be 5 volts. This signal is fed to an Inverting Amplifier which will invert & amplify the signal. This inverted amplified signal is again fed to a high voltage amplifier circuit for large amplification. Then again this signal is given to a Darlington Emitter Follower Circuit whose output is then given to patient through electrodes for nerve stimulation.

The stimulus should produce a monophasic and rectangular waveform, and the length of the pulse should not exceed 0.2 to 0.3 millisec. Stimulation at a constant current is preferable to stimulation at a constant voltage because current is the determinant of nerve stimulation. Also, for safety reasons, the nerve stimulator should be battery operated, include a battery check, and be able to generate 60 to 70 milliampere, but not more than 80 milliampere.

Any superficially located peripheral motor nerve may be stimulated. The ulnar nerve is the most popular site. The median, the posterior tibial, common peroneal, and facial nerves are also sometimes used. Because different muscle groups have different sensitivities to neuromuscular blocking agents, results obtained for one muscle cannot be extrapolated automatically to other muscles.

GALVANIC SKIN RESPONSE

Though there are many quantitative indicators of pain [3], this work aims only to check whether Galvanic Skin Response (GSR) can be used as a valid pain indicator or not. GSR measures the level of autonomic system activity by measuring the electrical resistance of the tissue path between two electrodes applied to the skin. The term 'pain' here is limited to only for mechanically stimulated pain and not the actual pain. The experiments are done in laboratory set up, not in clinical set up. To analyze the relationship between GSR and pain we measure GSR while controlled pain stimuli are applied. The physiology says that there would be change in skin resistance due to pain. In majority of cases the GSR is recorded by the change of electrical resistance of the skin to a direct current [4, 5]. This change in skin resistance is due to perspiration. For design purpose the skin resistance can be considered as 10, 100, 250 K Ω and 1 M Ω [5]. In this work a circuit is developed to deliver constant current of 5μ Ampere. The reason for keeping the current as 5μA is to minimize the polarization at the electrodes [4].

This experiment gives the response of GSR during pain and no pain conditions. This experiment is conducted in laboratory set up. The same ambient condition is maintained for all the subjects during all the stages of experiment. A mechanical pain stimulus is given to all the subjects. The output from the circuit is only the voltage from the subject's skin. This voltage output is then given to a level indicator. Before making involvement in the experiments, the subjects will be well taught about the experiments and they will be prepared for the same. In the experiment, the electrodes are placed in the appropriate place. This experiment is performed in 3 stages, namely Pre Pain, During Pain and Post Pain stages.

In the Pre Pain stage, the readings are taken from the subject when he/she is not given with any pain stimuli. In the During Pain stage, the pain stimulus is given externally to the subject. The pain can be created by placing 4 iron discs of 1.25 Kg weight each on right hand fingers. The discs are placed for 10 minutes continuously. And after 10^{th} minute the readings are taken for 10 seconds. In the Post Pain stage of experiment the iron discs from fingers are taken out and the subjects are allowed to relax for 5 minutes. After 5 minutes the GSR reading for Post Pain stage is measured for 10 seconds. These results show that any type of arousal is increasing the conductivity of skin-GSR [5]. From these results, we can conclude that the relationship between GSR and Pain is vital to be considered and GSR could be the indicator of pain.

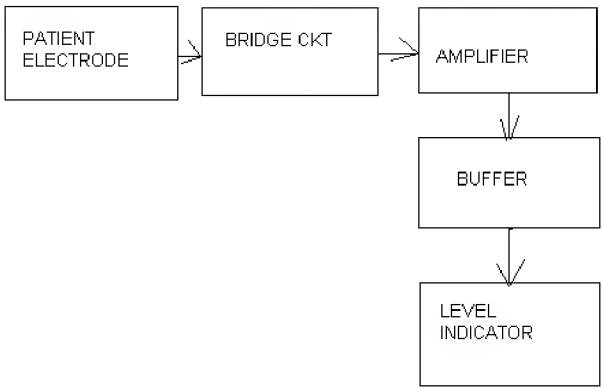

Figure 2: Block Diagram of Galvanic Skin Response

The Block Diagram (Figure 2) measures Galvanic Skin Response (GSR). During pain GSR is going to change. This change will give different voltage output from the Bridge Circuit. This voltage will be amplified by the Non-Inverting Amplifier with certain gain. This output of amplifier is fed to a Buffer & then given to a level indicator which consists of an array of LED. So depending upon the input different LED's will be lighting. Change in pain due to GSR will give different output which is indicated on the LED.

This work aims to verify whether Galvanic Skin Response (GSR) can be used as a valid pain indicator and to analyze the changes in GSR during analgesic condition. The experiments are done under pain and no-pain conditions on subjects of both the gender in the different age group. We use 4 iron discs of 1.25 Kg each to create mechanical pain for experiment in our laboratory set up. The change in conductivity of skin is observed in 'During Pain' stage of experiment [7]. The results of experiment show a clear relation between Pain and GSR and there is a scope for measuring pain objectively using GSR. The subjects do not feel pain during analgesia, and GSR is a true indicator of pain.

CONCLUSIONS

The specific goal of this work is to design and prototype a device which will quantitatively measure the pain and control the administration of analgesic to the sufferers of pain in order to reduce the side effects of the pain killers. And also this work aims to analyze the changes in GSR during analgesic condition. The conductivity of subjects increases in the 'During Pain' stage. And the conductivity is less in the other stages. It shows a clear relation between Pain and GSR and there is a scope for measuring pain objectively using GSR. However the relation between pain and other physiological parameters have to be studied before accepting GSR as an indicator of pain. The subjects do not feel pain during analgesia, and GSR is a true indicator of pain. In this work experiments are done with induced pain, in spite of real pain. The induced pain may not be the representative of all types of pains, but some type of pains. Thus this work include experiments with

subjects in a laboratory setup with pain, and this could help to design a device which will measure the pain objectively, in order to alleviate the pain effectively with just required amount of pain killers.

ACKNOWLEDGEMENTS

We wish to acknowledge our extreme gratitude to our guide, **Prof. Jyothi Warrier**, and Head of the Department **Dr. G. D. Jindal**, for guiding us throughout the work.

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